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watersmartinnovations.com
A new disruptive green & safe technology in Biocide Water Treatment

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2. Amoéba’s disruptive technology
3. *Willaertia magna C2c Maky* application
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A new biopesticide for industrial water treatment

- Amoéba has developed a unique patented biopesticide effective to kill waterborne bacteria, including *Legionella pneumophila*.

- It is the first biopesticide to control microbial slime in industrial cooling towers.

- It is classified as ‘non-hazardous for human health & the environment*’.

*An alternative solution to chemical biocides used in cooling circuits.*

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*In accordance Globally Harmonized System of Classification and Labelling of Chemicals*
Willaertia magna C2c Maky application

- **Willaertia magna C2c Maky** is injected in the make up water

- Routine concentration ranging from 7,600 to 380,000 cells/gallons

- Regular dosage of Wm’s product used:
  - 10 to 65 ppm for the 3% conc. (0.85 to 8.5 oz per 1,000 US gallons)
  - 2 to 20 ppm for 10% conc. (0.27 to 2.6 oz/1,000 US gallons)
  - 1 to 6.5 ppm for 30% conc. (0.1 to 0.85 oz/1,000 US gallons)
The only biopesticide for industrial water treatment without any ‘class of hazards to human health and the environment’*

*In accordance with regulation (EC) No 1272/2008 on classification and labeling of substances and mixtures
Amoébas’ disruptive technology
• Based on a 100% natural microorganism: 
  *Willaertia magna C2c Maky*

  • It is a non-genetically modified microorganism isolated from the thermal baths of Aix-les-Bains (France).

  • It belongs to the protozoan order, among eukaryotic unicellular mobile microrganisms (with flagelle).

Different *Willaertia magna* strains exist:
- only « *C2c maky* » strain has such properties
Amoéba’s disruptive technology

Willaertia magna C2c Maky:
• A natural predator of bacteria, including *Legionella*, and other smaller amoebas
Biofilm buildup on circuit surfaces

- Continuous flow of microorganism
- Biofilm containing $10^5$ to $10^7$ cells/cm²

Inlet water → Microorganism discharge

Continuous flow of organic and inorganic material

Circulating water containing $10^3$ to $10^5$ cells/mL

⇒ Meaning $\geq 95\%$ of total bacteria

Biofilm buildup speed up with:

- higher temperature: 77 to 108°F in cooling tower circuits
- presence of nutriments:
  - organic: biodegradable material
  - inorganics: Fe, Ca, ...

⇒ Meaning $\leq 5\%$ of total bacteria
The « Biofilm » challenge

**Matrix function:**

- **structural**
  
  (Sutherland et al., 2001)

- **nutritive**
  
  (Gagnon et Huck, 2001)

- **protective**
  
  (Allison et al., 2000)

**Microbial risks** in water systems

= pathogen bacteria development and presence

**Challenging Disinfection**

- Resistance mechanism from active bacteria (Gilbert et al., 2003)

- Higher consumption of disinfectant because of a limited efficacy of chemical biocides (Kiéné et Lévi, 2002)
Efficacy of Amoéba’s biopesticide program:

A Representative results from Illinois cooling tower used for plastic molding
Test in Illinois, at a Plastic Extruder (food-grade plastic Cutlery and Cups production)

- **Circuit Characteristics**: 
  - Industrial Cooling Towers (2), semi-open, induced air
  - Cooling Tower Power = 600 Tons (~2000 kWatts)
  - MU = 29,000 Gallons/day (~110 m³/day)
    - Municipal potable water from Lake Michigan
    - Microbial quality assessed with no significant bacterial contamination

- **Test duration**: 8 months (from Oct 2017 to end of May 2018)

- **Biomeba Dosage**
  - Colonization phase = 7.4 ppm WM for 1 month
  - Intermediate dosage = 2.6 ppm WM for 1 month
  - Routine dosage = 0.7 +/- 0.1 ppm WM = >0.9 oz.fl /1000 Gal. (7 ml/m³)
  - of 10% conc. Biomeba
Results on bioslime

Monitoring of bioslime mass using the biofilm test kit

- **Control phase - Chemical**
- **Test phase - BIOMEBA (target)**
- **Biofilm test kit results**
Amoéba’s industrial tests in USA

Results on Slime forming bacteria

Monitoring of Slime Forming Bacteria in cooling water using dip slides

[Graph showing data on monitoring of slime-forming bacteria over time.]

- Control phase - Chemical
- Test phase - BIOMEBA (target)
- Dip slides - Slime-Forming Bacteria

Y-axis: BIOMEBA treatment concentration (1E+07 W/m^2)
X-axis: Dates from 2017 to 2019

Legend:
- Control phase - Chemical
- Test phase - BIOMEBA (target)
- Dip slides - Slime-Forming Bacteria

Graph shows a decrease in slime-forming bacteria concentration over time in the test phase compared to the control phase.
Amoéba’s industrial tests in USA

Results on total viable bacteria

Monitoring of total viable bacteria in cooling water using culture method
Results on *Legionella pneumophila* (measurement by qPCR)
Amoéba’s disruptive technology

And a capital difference with chemical biocides...

Efficient in water and in the biofilm

Amoéba’s biopesticide

95% of the bacterial risk

comes from the Biofilm

Inefficient on the biofilm

Chemical treatments kills only

bacteria into the water phase =>

5% of the risk

Amoéba’s biopesticide: powerful, effective to control microorganisms in water & the biofilm

*Dalkia Study - June 2008: 99.5% of Legionella are found in biofilms*
Amoéba’s disruptive technology

- A proven technology tested on real industrial sites in North America & Europe

<table>
<thead>
<tr>
<th>Business sector</th>
<th>Number of tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food industry</td>
<td>4</td>
</tr>
<tr>
<td>Chemistry</td>
<td>5</td>
</tr>
<tr>
<td>Heavy industry</td>
<td>4</td>
</tr>
<tr>
<td>Commercial building</td>
<td>6</td>
</tr>
<tr>
<td>Automotive</td>
<td>1</td>
</tr>
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<td>Aviation</td>
<td>2</td>
</tr>
<tr>
<td>Pharmaceutical</td>
<td>2</td>
</tr>
<tr>
<td>Electronic</td>
<td>1</td>
</tr>
<tr>
<td>Plastic industry</td>
<td>1</td>
</tr>
</tbody>
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Some examples: Häagen-Dazs (part of General Mills) & ArcelorMittal

10 cumulated years of conclusive field trials on 31 end users’ sites
Examples of corrosion reduction with *Willaertia magna C2c Maky* vs chlorine

International Airport trial

<table>
<thead>
<tr>
<th>Corrosion indicators</th>
<th>% of reduction vs oxydising biocide Program</th>
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<tbody>
<tr>
<td>Steel corrater measurement</td>
<td>- 87 %</td>
</tr>
<tr>
<td>Copper corrater measurement</td>
<td>- 84 %</td>
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Corrater Amoeba CT: 0.6um
Corrater competitor CT: 2.5 um

=> 4 times less corrosion with *Willaertia magna C2C Maky*
Amoéba’s disruptive technology

• Less carbon footprint

Amoéba’s biopesticide

Easy to handle packaging

100% recyclable

2.6 or 5.2 gallons

PLUG & PLAY Technology

VS

Transport

Higher volumes , Large storage place

PPE
Positive environmental impact with Amoéba

Clean discharge for environment
Recreation basin collecting the blow-down of a cooling tower treated with

chemical biocides

Willaertia magna C2c Maky
Willaertia magna C2c Maky application
Biopesticide application procedures

- *Willaertia Magna C2c Maky* preferred life conditions:

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<table>
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<tr>
<td><strong>Hardness</strong></td>
<td>some ppm Ca improves <em>Willaertia magna C2c Maky</em>’s metabolism</td>
</tr>
<tr>
<td>Optimal temperature</td>
<td>55 to 125 °F (25° to 45 °C)</td>
</tr>
<tr>
<td>Salinity resistance</td>
<td>0 to 9% (doesn’t perform in sea water)</td>
</tr>
<tr>
<td><strong>pH</strong></td>
<td>from 5 to 10</td>
</tr>
<tr>
<td>Resistance to chlorine</td>
<td>up to 3.5 ppm free Cl₂ (7 ppm monochloramine)</td>
</tr>
<tr>
<td>Resistance to non oxidizing biocides</td>
<td>&lt;0.1 ppm</td>
</tr>
<tr>
<td>Compatibility with anti-scalant &amp; anti-corrosion programs</td>
<td>generally does not cause any problem but has to be validated by Amoeba</td>
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Conclusions
Conclusions

• *Willaertia magna C2c* Maky is a true green program:

1. **100% organic**
   - 100% degradability in less than a week

2. **100% biodegradable**
   - No release of toxic residues in the environment

3. **No residues**
   - Easier procedures to get Waste Water discharge permit
Conclusions

• **Willaertia Magna C2c Maky** efficiency vs risk

  • Active on bacteria planktonic form
  • Active on bacteria sessile form
  • Active into bioslime
  • Active on other free living amoebas

  ![Efficiency](image)

  ↓ Environmental impacts

  ↓ Risk

  • Clean environnemntal discharge
  • Lower carbon footprint
  • No human toxicity
  • No Eco-toxicity
  • No pathogenicity
The active component *Willaertia magna C2c Maky* is:

- the **first and unique** green biocide to control bacteria and bioslime risks in cooling water systems. It can be applied without any investments and gives an ecological answer to water treatment.

**This treatment program avoids chemical biocide discharge in the environment**
Contact information

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